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Federal Aviation Administration

Advisory Circular

Subject: GENERIC VISUAL GLIDESLOPE INDICATORS (GVGI)

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1. PURPOSE. This advisory circular (AC) contains the Federal Aviation Administration (FAA) standards for generic visual glideslope indicator (GVGI) systems. GVGI systems provide pilots with visual glideslope guidance during approaches for landing at general aviation airports.

2. APPLICATION. These standards are recommended by the FAA for general aviation airport applications and systems meeting these standards are eligible for funding under the Airport Improvement Program.

3. METRIC UNITS. To promote an orderly transition to metric units, this advisory circular includes both English and metric dimensions. The metric conversions may not be exact equivalents, and until there is an official changeover to the metric system, the English dimensions will govern.

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GENERIC VISUAL GLIDESLOPE INDICATORS

1. SCOPE AND CLASSIFICATION.

1.1 Scope. This specification covers the requirements for generic types of visual glideslope indicators for general aviation airports; i.e., airports not operating under FAR 139.

1.2 Classification. The generic visual glideslope indicator (GVGI) systems shall be as classified below.

1.2.1 Types.

a. Type L-882 Systems - Multiple projector systems.

b. Type L-883 Systems - Single projector systems.

1.2.2 Styles.

a. Style A - Voltage powered systems.

b. Style B - Current powered systems.

1.2.3 Classes.

a. Class I - Systems which operate between +130°F (+55°C) and -30°F (-35°C).

b. Class II - Systems which operate between +130°F (+55°C) and -65°F (-55°C).

2. APPLICABLE DOCUMENTS. The following documents, of the issue in effect on the date of application for qualification, form part of this specification and are applicable to the extent specified herein.

2.1 Federal Aviation Administration (FAA) Publications.

a. FAA Advisory Circulars (AC).

AC 150/5345-1	Approved Airport Lighting Equipment
AC 150/5345-10	Specification for Constant Current Regulators And Regulator Monitors
AC 150/5345-47	Isolation Transformers for Airport Lighting Systems
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems (for information only)
AC 150/5345-49	Specification L-854, Radio Control Equipment

b. FAA Standards and Drawings.

FAA-STD-020	Transient Protection, Grounding, Bonding, and Shielding
Drawing C-6046	Frangible Coupling, Type 1 and 1A, Details

2.2 Military Specifications and Standards.

MIL-C-25050	Colors, Aeronautical Lights and Lighting Equipment, General Requirements for
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-462	Electromagnetic Test Methods

(FAA advisory circulars may be obtained from the Department of Transportation, Utilization and Storage Section, M-443.2, Washington, D.C. 20590.)

(FAA standards, specifications, and drawings may be obtained from the Federal Aviation Administration, Program Engineering and Maintenance Service, Washington, D.C. 20591.)

(Military publications may be obtained from the Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120, Attention Code CDS.)

3. REQUIREMENTS.

3.1 Approval Process. The GVGI approval process consists of a signal concept flight evaluation (Phase 1) and equipment performance testing (Phase 2). Proposed system designs must pass both phases in sequence before approval is granted. Under Phase 1 a design installation will be flight tested by the FAA. The pattern will be flown several times both day and night. Glideslope sector signals will be observed and recorded. Observed items will include but not be limited to; ease of interpretation, signal conflict with airport equipment (beacons, support equipment, fire and rescue, etc.), conspicuity, and color. Phase 2 tests consist of environmental, photometric, mechanical, and operational tests. Failure of the equipment to pass all tests shall be cause for rejection.

3.2 Application for Approval. Procedures for applying for qualification approval to this specification are contained in AC 150/5345-1, Approved Airport Equipment. The application for approval shall include as a minimum; detailed drawings which indicate the principle of operation, photometric data consisting of iso-candela curves showing all glideslope sector signals and data for horizontal and vertical beam spread. Under Phase 1, the design will be evaluated using the design requirements of 3.3 as a guide. If review indicates the criteria can be met, Phase 1 evaluation will be scheduled.

3.2.1 Signal Concept Flight Evaluation. The test site will be selected by the FAA. Equipment to be tested shall be supplied by the manufacturer. The installation may be made by the FAA in accordance with the manufacturer's instructions or made by the manufacturer with approval of the FAA. The flight test and evaluation will be performed by the FAA. A copy of the flight test report and test procedures shall be given to the manufacturer upon conclusion of the evaluation.

3.2.2 Approved Design Data. The FAA may recommend changes or approve the proposed system design contingent on incorporation of FAA recommendations during Phase 1 tests and reviews. Photometrics and signal characteristics of the revised design shall be submitted to the FAA prior to the Phase 2 tests.

3.2.3 Previous Approvals. Proposed systems employing signal concepts identical to signals generated by FAA approved equipment as listed in AC 150/5345-1 will not require Phase 1 testing. However, Phase 2 testing will be required. PAPI systems listed in AC 150/5345-1 which have been approved to AC 150/5345-28 are considered as meeting both Phase 1 and Phase 2 requirements of this specification.

3.3 Design Requirements.

3.3.1 Visual Range. The signal shall be conspicuous at a range of not less than 6 statute miles (9 km) on a bright clear day. Interpretation of the signal (i.e., the ability to distinguish differences between each sector of the signal) shall occur at not less than 4 miles (6 km) from the signal source. For purposes of this evaluation, the term bright clear day is defined as a day where the visibility is 10 to 15 miles (20 km) as defined by the National Weather Service, clear sky and full sun. The signal shall be observed between 10:00 AM and 3:00 PM.

3.3.2 Overall Beam Pattern. The overall beam pattern shall consist of an oval shape with the major axis parallel and the minor axis perpendicular to the plane of the runway. Iso-candela curves shall be concentric ovals centered about the intersection of the major and minor axes.

3.3.3 Vertical Beam Width. Guidance shall be provided relative to the on-glideslope signal over a vertical angle not less than +/- 4 degrees from the axis of the on-glideslope signal. The on-glideslope signal shall be distinct and shall be between 0.33 and 0.5 degrees wide vertically and centered on the glideslope signal axis.

3.3.4 Horizontal Beam Width. The visual signal shall provide guidance relative to the approach angle over a horizontal angle of not less than +/- 10 degrees from the center of the light beam.

3.3.5 Colors. The visual signal shall consist of not less than two and not more than four horizontal color bands. These colors shall be aviation colors in accordance with MIL-C-25050. The colors shall be red, yellow, green, or white. Color sectors shall be distinct and identifiable throughout the horizontal beam width at all intensity settings. Only red shall be used to indicate the lowest below-course sector of the system. Transition zones between colors shall be not more than 0.05 degree when used strictly for color separation.

3.3.6 Signal Interpretation. The signal shall consist of multiple sectors. These sectors shall be unique and indicate as a minimum above-, on-, and below-glideslope conditions.

3.3.7 Fail-Safe Failure Mode. The system shall be designed to be fail-safe on any system failure which results in an incorrect glideslope signal being transmitted from the system. For this equipment the fail-safe mode is considered to be with the system turned off.

3.3.8 Intensity Settings. Photoelectric or manual control with a minimum of two intensity settings shall be provided. Intensities shall be consistent with the regulator settings for style B systems. For style A systems intensities shall be similar to those provided by regulator supplied systems. Intensities shall be approximately 20 and 5 percent of full intensity.

3.3.9 Flash Frequency and Duration. The frequency of flashing, if used, and the duration of the flashes shall be specified by the manufacturer.

3.3.10 Environmental Requirements. The equipment shall be designed for outdoor installation and continuous or intermittent operation with routine maintenance for a 20 year life under the following environmental conditions:

a. Temperature. Any temperature from +130°F (+55°C) to -30°F (-35°C) (Class I systems) or to -65°F (-55°C) (Class II systems).

b. Humidity. Relative humidity to 95 percent.

c. Sand and Dust. Exposure to windborne sand and dust particles.

d. Wind-blown Rain. Exposure to wind-blown rain from any direction.

e. Wind. Exposure to wind speeds up to 100 mph (160 km/hr) from any direction.

f. Salt Spray. Exposure to a salt-laden atmosphere.

g. Sunshine. Exposure to solar radiation.

3.3.11 Lamp Life. The lamps shall be commercially available types using standard lampholders and have a minimum lamp useful life of 1000 hours when operated at the high intensity setting. Lamp useful life is defined as the life of the lamp when installed in the projector and operated as designed by the manufacturer. Automatic lamp changing may be used to comply with this requirement provided that signal interruption does not last for more than 2 seconds. Lamp life testing shall be used to define lamp life.

3.3.12 Light Unit Construction. Each projector unit shall be designed with the following characteristics:

a. Environmental Loads. Dynamic and static environmental loads due to wind, snow, etc., shall not cause misalignment of the light signal.

b. Weight. The weight of the complete unit shall not exceed 150 pounds (65 kg). If transformers are mounted separately, this weight shall be reduced to 100 pounds (45 kg).

c. Height. The complete installation when installed in the minimum configuration shall not exceed 40 inches (1 meter) from ground level to the top of the unit.

d. Enclosure. Unit enclosures shall be impervious to ultraviolet radiation and shall prevent rain and snow from degrading light signal characteristics.

e. Start up. The visual signal shall display correct color characteristics and intensities within 5 seconds of turn on.

f. **Filters and Lenses.** Filter and lenses shall be stable and not change characteristics under all operating conditions.

3.3.13 Mounting Provisions. The light units shall provide for mounting on a maximum of three frangible couplings and shall be suitable for mounting on a level concrete pad. Hardware shall be provided for leveling the unit and shall be designed to prevent displacement of the optical system due to vibration. Alternate mounting systems may be proposed which provide equivalent rigidity, frangibility, and adjustment.

3.3.14 Aiming. The light unit(s) shall be provided with integral adjustments to permit vertical positioning of the "on-glideslope" signal axis at any elevation between 1 and 12 degrees to +/- 0.08 degree of arc. A separate aiming device may be furnished to set the vertical angle.

3.3.15 Tilt. All systems shall be provided with a device which de-energizes all projector unit(s) when the on-glideslope signal axis is misaligned between 0.25 and 0.5 degrees below or between 0.5 and 1.0 degree above the preset on-glideslope angle. A time delay of 10 to 30 seconds shall be included to prevent intermittent activation caused by vibration. Adjustments shall be provided to simulate the excessive tilt conditions for checking operation of the tilt device.

3.3.16 System Control. System control shall be designed as specified by the user for remote manual, radio control, or photoelectric control or any combination of these.

a. **Remote Manual Control.** The remote manual control may use either 120VAC or 48VDC.

b. **Radio Control.** The radio control shall be in accordance with AC 150/5345-49. It shall activate the system and, if required, select the intensity setting.

c. **Photoelectric Control.** The photoelectric control unit shall automatically select the pre-set day or night intensity setting. The control unit shall select the day intensity as illumination on the photocell rises to 50-60 footcandles (540-645 lux) and the night intensity as the illumination drops to 25-35 footcandles (270-375 lux). A time delay of 45 to 75 seconds shall be incorporated. In case of photoelectric control failure, the system shall revert to low intensity. Style A systems shall select the low night intensity setting for 3 seconds before switching to the day intensity setting.

3.3.17 Transient Suppression. Power units of style A systems shall withstand lightning transients of 8x20 microsecond current surges of 15,000 amperes minimum with the subsequent power-follow current and a voltage surge of 10 KV/microsecond. The system shall also withstand without damage repeated application of overvoltage transients on the input power lines of 500 volts peak with a duration of 50 milliseconds. Failure of one or more lamps shall not damage the remaining lamps.

3.3.18 Style A Systems. These systems shall operate on 120, 240 or 480 volts alternating current nominally. Other voltages may be specified by the user.

3.3.19 Style B Systems. These systems operate directly from a constant-current regulator with a current range of 2.8 to 6.6 amperes as specified in AC 150/5345-10 and listed in AC 150/5345-1. Lamps shall be compatible with a type of isolation transformers in accordance with AC 150/5345-47 and listed in AC 150/5345-1.

3.3.20 Grounding. Conductive materials enclosing electrical conductors, equipment, or housing part of such equipment shall be grounded to a common lug to allow connecting to a system ground conductor.

3.3.21 Power Cables. Equipment shall be provided with power cables having factory molded plugs. Length of cable shall not be less than 1.5 ft. (75 cm). Style A systems shall use any plug with adequate capacity and performance equivalent to that of an L-823 plug as specified in AC 150/5345-26. Style B systems shall have class A, style 1 or 6 plugs as specified AC 150/5345-26 to mate with isolation transformer output.

3.3.22 Equipment Color. The exterior of all units shall be either a bright orange or yellow.

3.3.23 Identification Label. Each fixture or unit shall be marked with a permanent label including the manufacturer's name and address; the name, number, type, style, class, and the electrical rating.

3.3.24 Hardware. All hardware shall be selected to prevent galling.

3.3.25 Maintenance. System components shall be designed to allow replacement. The design shall be such that adjustment and repairs can be made with standard tools.

3.3.26 Workmanship. Wiring shall be neatly run and bundled. Wiring shall be marked by color coding or tagging. Wire marking shall be consistent with instruction book schematics and troubleshooting diagrams. Sharp edges and burrs shall be removed. Painted surfaces shall be free from runs, blotches, and scratches.

3.3.27 Instruction Book. An instruction book containing the following information shall be furnished with each system.

a. Complete schematic and wiring diagrams referencing wire markings and showing all components cross-indexed to the manufacturer's parts list. Wire marking on schematic shall be identical to marking on equipment.

b. Complete parts list, including bill of materials with applicable rating and characteristics of each part and with the component manufacturer's name and part number.

c. Installation instructions, including aiming, sighting criteria, calibration of the aiming system, focusing, and adjustment of the tilt device.

d. Physical description, including photographs or drawings with sufficient detail to identify the components.

e. Maintenance instructions, including relamping procedure, theory of operation, and trouble-shooting charts.

f. Operating instructions.

4. TESTING.

4.1 Testing shall consist of signal concept flight evaluation (Phase 1 Tests) and equipment performance testing (Phase 2 Tests). Phase 2 tests shall be conducted in the specified sequence on the same unit(s). The test sequence is designed to simulate accelerated environmental effects.

4.2 Phase 1 Tests. Phase 1 tests consist of the signal concept flight evaluation tests and shall include the following documents and any revisions as required for approval:

a. Flight evaluation Test Report,

b. Approved design data package including detailed drawings,

c. Signal characteristics,

d. Photometric data package, and

e. Description of principles of operation.

f. Lamp life test procedure.

These documents must be on file at the Office of Airport Standards prior to Phase 2 tests.

4.3 Phase 2 Tests. The equipment to be subjected to Phase 2 tests shall be items intended for production. Unless specifically directed in the test procedures referenced by this specification, equipment may not be disassembled or cleaned once the test sequence has begun.

4.3.1 Phase 2 Acceptance Criteria.

4.3.1.1 Flash Frequency and Duration. The frequency of flashing, if used, and the duration of the flashes shall be within manufacturers specifications.

4.3.1.2 Safety Features. Any deterioration or reduction safety feature performance will be cause for test failure.

4.3.1.3 Loss Of Signal. Loss of signal shall be cause for test failure.

4.3.1.4 Visual Examination. The equipment will be examined for compliance with the requirements on size, weight, materials, finish, identification label, and quality of workmanship. Failure to meet weight and size restrictions shall be cause for rejection.

4.3.2 Phase 2 Tests.

4.3.2.1 Solar Radiation Test. A sunshine test shall be conducted in accordance with MIL-STD-810, Method 505.2, Procedure II for nonmetallic exterior parts. The material shall be subjected to 56 cycles. If optical lenses or light emitting covers of plastic are used, the photometric performance shall be measured after this test. Certification from the plastic manufacturer that the material has previously passed this test may be provided in lieu of performing this test on the part certification is provided for.

4.3.2.2 Humidity Test. The humidity test shall be in accordance with MIL-STD-810, Method 507.2, Procedure III, except a total of three cycles (72 hours) will be required and the maximum temperature shall be +130°F (+55°C).

4.3.2.3 Low Temperature Test. A low temperature test shall be conducted in accordance with MIL-STD-810, Method 502.2, Procedure II. The system shall be exposed to a minimum of -30°F (-35°C) (for Class I systems) or -65°F (-55°C) (for Class II systems) for 24 hours. Projector unit(s) shall be initially de-energized and shall be energized during the last 12 hours of the test.

4.3.2.4 Sand and Dust Test. The sand and dust test shall be in accordance with MIL-STD-810, Method 510.2, Procedure I, except steps 5 through 8 and 10 shall be omitted. The light unit shall be rotated for two 120 degree increments, and the air velocity shall be 2,500 +500 feet (760 +150 m) per minute. Projector unit(s) shall be de-energized during this test.

4.3.2.5 Salt-Fog Test. A salt-fog test shall be conducted in accordance with MIL-STD-810, Method 509.2, Procedure I. The unit shall be cycled per Paragraph I-3.2.4 for four periods. Any evidence of rust, pitting, or corrosion shall be cause for test failure.

4.3.2.6 Wind Loading. Static loading tests shall be conducted to assure that the system will withstand the specified wind load from any direction in azimuth without displacing the optical pattern more than allowed in the snow and ice loading test.

4.3.2.7 Snow and Ice Loading Test. A uniformly distributed load of 15 pounds per square foot (75 kg/m^2) shall be applied over the entire top surface of the projector unit(s). Before applying the load, the unit shall be set up and the light pattern displayed on a vertical surface 20 feet (6 m) from the front of the unit. The top, bottom, and the sides of the beam pattern and any other characteristic features shall be marked on the wall. After loading the unit with the required amount of material, the beam pattern shall be checked for displacement from the markings, and the load shall be left in place for 5 hours. Upon removal of the load, the beam pattern shall again be checked against the original markings. The beam pattern shall remain within +1/4 inch (6 mm) of the original markings.

4.3.2.8 Photometric Tests. The light units shall be tested after the above tests to assure compliance with the approved design data. Certification by the manufacturer of lenses and color filters may be used to meet the color requirements of MIL-C-25050. Photometric test equipment shall be calibrated with the calibration traceable to the National Bureau of Standards.

4.3.2.9 Computation of Effective Intensity. The effective intensity of flashing lights shall be calculated in accordance with the following formula. Intensities which are 90 percent or more of those specified by the manufacturer are acceptable.

$$I_e = \int_{t_1}^{t_2} Idt/(0.2+(t_2 - t_1))$$

Where:

I_e = Effective intensity (K candela)

I = Instantaneous intensity (K candela)

t_1, t_2 = Integration limits (seconds)

The limits of integration shall be selected so that the value of I_e is maximized.

4.3.2.10 Frangibility Test. The manufacturer shall demonstrate that the frangibility is not less than that provided by an equal number, not to exceed three, 2-inch type FAA frangible couplings as defined on FAA drawing C-6046. This may be demonstrated by measuring the force required to break the coupling.

4.3.2.11 Aiming Tests. The vertical and horizontal adjustment ranges of the light units shall be measured for compliance with the requirements of 3.2.14, Aiming. The aiming device shall be tested, using a procedure approved by the FAA, to demonstrate that, when the light unit is moved via the adjustment mechanism, the measuring device registers the change within the allowable tolerance. The measuring device shall be checked at one degree intervals throughout the system's adjustment range.

4.3.2.12 Operational Test. The manufacturer shall conduct an operational test, using a test procedure approved by the FAA, to demonstrate compliance with all operating requirements. The procedure shall test the tilt device, the power supply performance, photoelectric controller, and any other operational features. If more than one lamp is used in a projector, the system shall be operated with one lamp out in each projector to demonstrate that the proper voltage or current is still applied at the sockets of the operational lamps. The manufacturer shall demonstrate that failure of a lamp will not produce transients large enough to damage the remaining lamps and that lamp changer changes lamps automatically.

4.3.2.13 Transient Suppression Test. The power input lines shall be tested for resistance to lightning transients in accordance with method CS06 of MIL-STD-462, including Notices 1, 2, and 3. These systems shall be tested for resistance to the overvoltage transients given in paragraph 7a(3) of this MIL-STD. After the transients have been applied to the system, it shall continue to supply specified voltage or current to the lamp sockets.

4.3.2.14 Life Life Testing. Lamp life testing shall be performed in accordance with AC 150/5345-1, Appendix 3.

4.3.2.15 Production Testing. The manufacturer shall submit for FAA approval a test procedure to verify the light output and aiming device accuracy for each production unit. After FAA approval, these tests shall be used on all production units. The visual examination, aiming test and the operational test in 4.3 shall also be performed on each item.